# Space Weather Technical Forecast

Issued on Wednesday, 13 July 2022 at 13:14 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Chance of R1-R2 blackouts, slight chance of R3 blackouts. Chance of G1/Minor Storms Day 1 (13 July). Slight chance of S1 throughout, with slight chance of Active fluence later in period.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Low, with only C-class flares in the last 24 hours. There are five sunspot regions on the visible disc. AR3055 remains the largest region but has decreased in size and is now magnetically simple, it is mostly inactive. AR3053 has developed a delta configuration within its intermediate penumbra. AR3056 in the SE has decreased in size and simplified with its trailing region fading. This region is not as active as it once was. AR3057 in the NE is developing slowly, with proliferation of spots and is now a magnetically complex beta-gamma group. AR3052 continues to fade and is now a simple unipolar group. There are numerous large filaments on the Sun, some of which spanning roughly 20 degrees on the solar disc. There were no signs of instability in these in the reporting period, however they will need to be monitored for any lift-off, particularly as some of them are now transiting across the western hemisphere. No Earth-directed CMEs were observed in available imagery in the last 24 hours.

**Solar Wind / Geomagnetic Activity:** The solar wind, as observed by DSCOVR at L1, has been slightly elevated to elevated between 450 and 530 km/s, most likely under the influence of the high speed stream originating from Ch99/+. The density was largely average. The IMF was mostly weak. The north-south component was weak and often near neutral. The phi angle was largely positive (away from the Sun), though did fluctuate into negative sectors for long periods from 13/0600 UTC. Geomagnetic activity was Quiet to Unsettled with a G1 / Minor Storm interval between 12/1200-1500 UTC.

**Energetic Particles / Solar Radiation:** The high energy proton flux (10 MeV), as measured by GOES16, is at background levels.
The high energy electron flux (greater than 2 MeV) remained at background levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold on a slightly rising trend. Observed fluence was 2.09e6 integrated pfu at 13/0001 UTC.

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# Met Office Space Weather Technical Forecast

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is expected to be Low to Moderate, with a slight chance of X-class flares.

**Solar Wind / Geomagnetic Activity:** The solar wind is expected to be mostly elevated or slightly elevated on days 1 and 2, under the influence of the HSS originating from CH99/+. However, it may be superseded by the arrival of a CME that left the sun on 09 July, perhaps increasing the solar wind to strong levels. This CME was expected to arrive early on day 1 (13th), though there remains a slight chance it could still arrive later on day 1 with confidence and effects decreasing rapidly over time. Otherwise, solar winds are expected to ease on days 3 and 4 (15th and 16th).
Overall geomagnetic activity is expected to be Quiet to Unsettled, with a Chance of Active to G1/Minor Storms should the late CME arrive. Geomagnetic activity then returning to mostly Quiet levels on days 2 to 4 (14th to 16th July).

**Energetic Particles / Solar Radiation:** The high energy proton flux (greater than 10 MeV) is likely to remain at background levels. There is however a daily Slight Chance of S1 or greater, due to the presence of relatively large sunspot regions transiting across the western hemisphere.

The high energy electron flux (greater than 2 MeV) may become high later in the period, the chance increasing over time. The corresponding electron fluence is expected to display a sharp rising trend from day 2 onwards, perhaps exceeding the Active threshold (1e8 integrated pfu) on day 4 (16 July).

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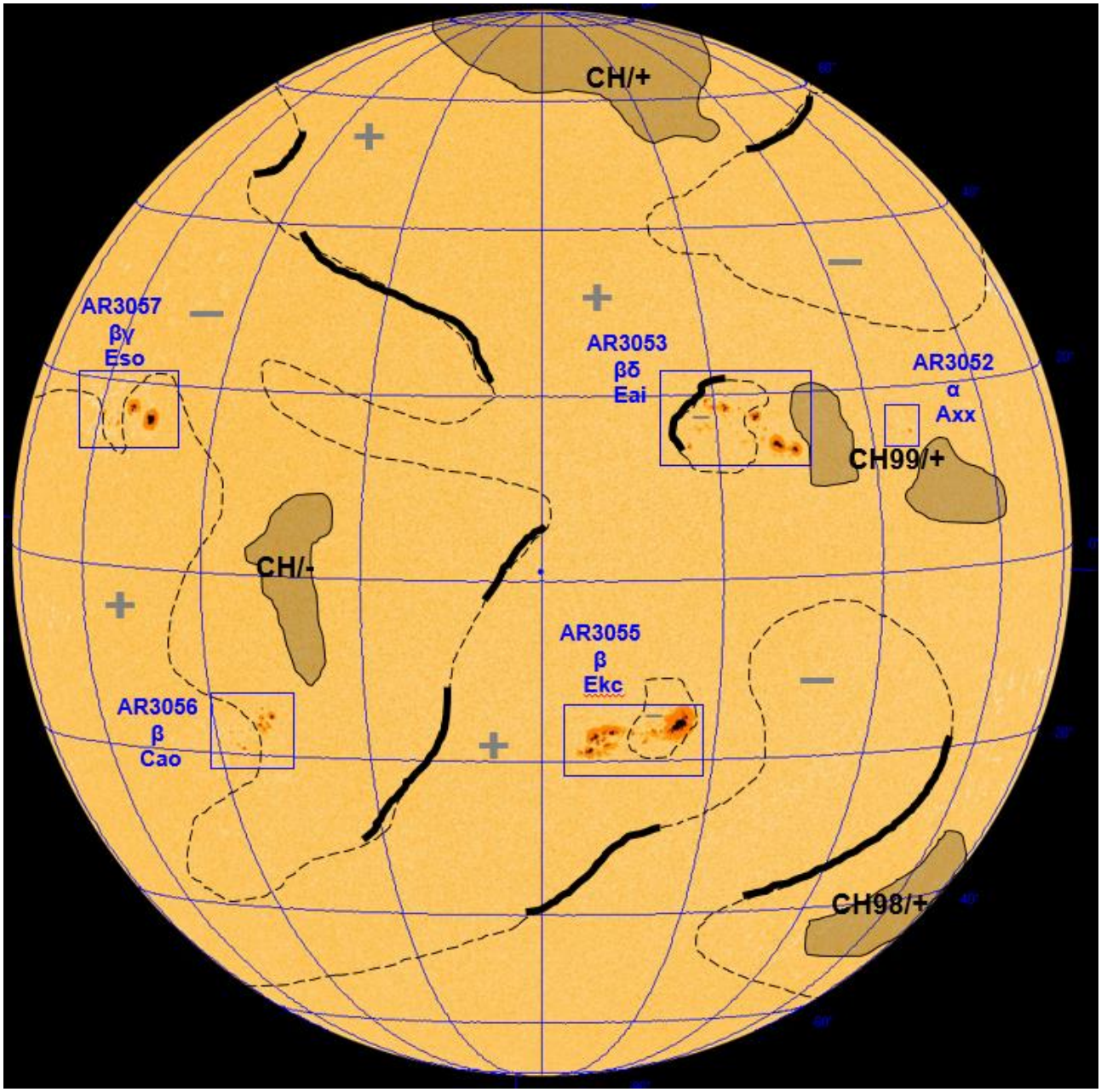
**Figure 1. Solar Analysis Valid 13/0700UTC.**

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**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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**Geomagnetic Storms:**

Earth may receive a glancing blow from a CME that left the Sun on the 09 July. While the bulk of the ejecta is expected to miss behind Earth's orbit, a glancing blow is considered still possible despite the forecast arrival time having already passed.

The solar wind is currently at elevated levels and is expected to remain enhanced on day 1 and day 2, under the influence of the high speed stream originating from CH99/+ and perhaps some minor contribution from CH98/+. CH99 is a recurring feature that generated speeds of 600 km/s on the previous rotation. However, due to its smaller size and fragmentation in the intervening month, it is hard to envisage similar speeds will be achieved this time around.

That said, any increase in the HSS may be superseded by the late arrival of the CME, perhaps increasing the solar wind to strong levels. Otherwise, solar winds are expected to ease on days 3 and 4 (15th and 16th).

Overall geomagnetic activity is expected to be Unsettled to Unsettled, with a Chance of Active to G1/Minor Storms under any CME effects. Geomagnetic activity then returning to mostly Quiet levels on Days 2 to 4 (14th to 16th July), with the odd Unsettled interval at times.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | Yes | 40 | 1 | 1 | 1 |
| Strong | G3 | No | 2 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

**Geomagnetic Activity - Earthbound Coronal Mass Ejections**

**Nil-** Though note a CME left the Sun around 120/0500UTC was just to arrive around 12/2200 UTC +/- 6 hours. There is a slight chance this feature may still arrive on the 13th July.

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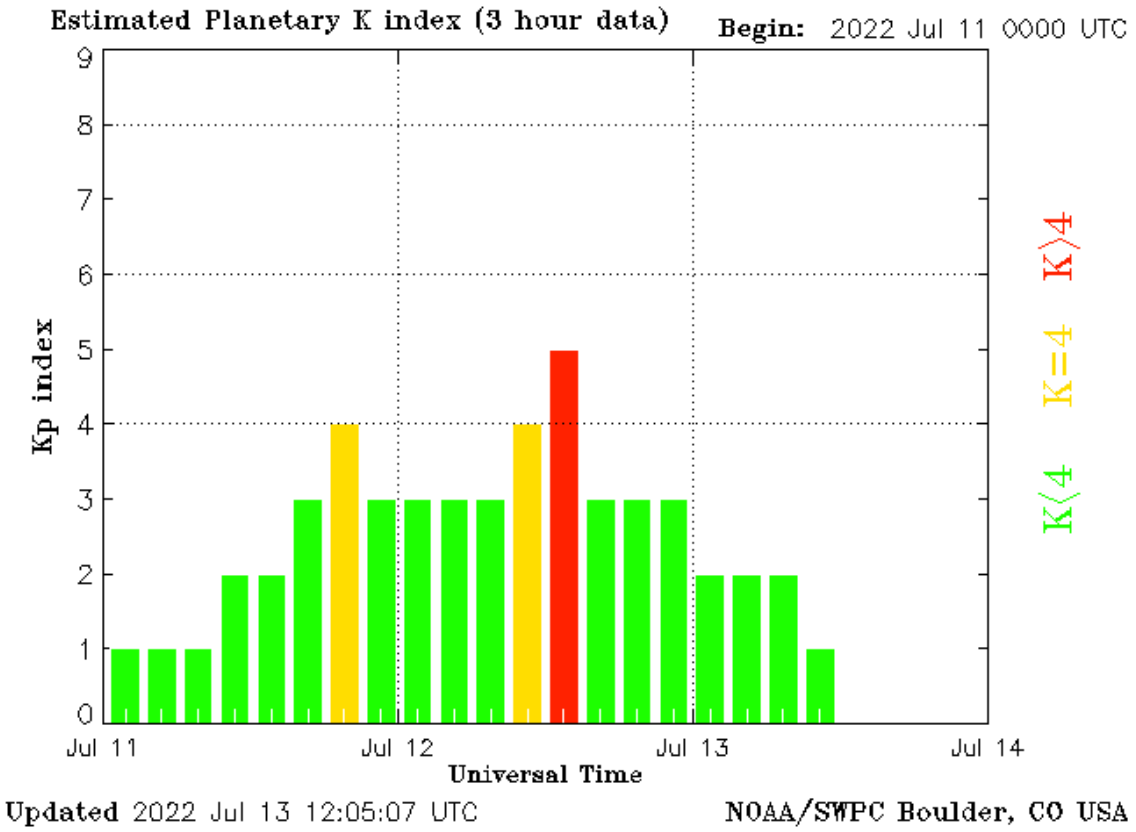
**Figure 2: Planetary K index (Kp) from NOAA SWPC.**

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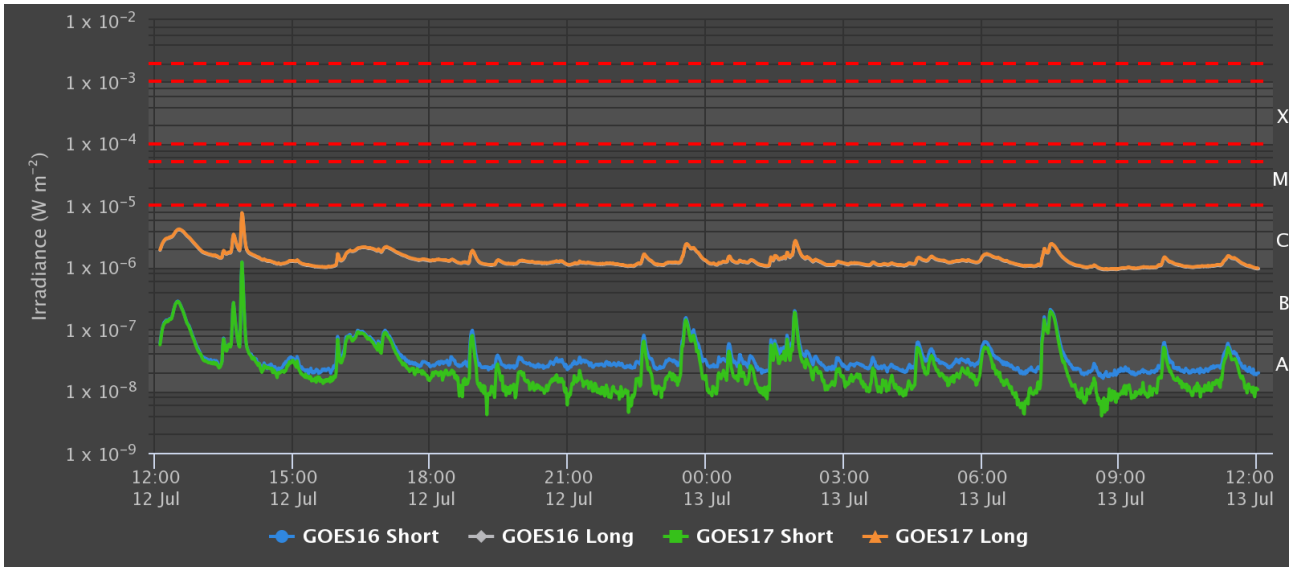
**Radio Blackouts - X-Ray Flares:**
Solar activity has been Low in the last 24 hours, with only C-class flares observed. Background x-ray flux is now in the C-class category however.
There are five sunspot regions on the visible disc. AR3055 remains the largest region but has decreased in size and is now magnetically simple, it is mostly inactive. AR3053 has developed a delta configuration within its intermediate penumbra. AR3056 in the SE has decreased in size and simplified with its trailing region fading. This region is not as active as it once was. AR3057 in the NE is developing slowly, with proliferation of spots and is now a magnetically complex beta-gamma group. AR3052 continues to fade and is now a simple unipolar group.
Solar activity is expected to be Low to Moderate, with a slight chance of X-class flares.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 50 | 50 | 50 | 50 |
| Very Active | R3 to R5 X Class | No | 15 | 15 | 15 | 15 |

**Figure 3: GOES16 X-Ray flares all below M (R1) Class.**

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## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is now back to background levels, after it became slightly elevated on the 09 July (in response to a C8 flare). There is a slight chance of S1 or greater, due to the presence of two relatively large sunspot regions transiting across the western hemisphere.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 15 | 15 | 15 | 15 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

## High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) is currently at background levels. CH99 is currently bringing elevated wind speeds which may cause some electron charging, however the possible late CME arrival on day 1 (13 July) would cause a temporary suppression in electron levels.

ElectronFlux levels are forecast to slowly increase over the next 4 days, with the 1e3 pfu active threshold being breached near the diurnal maximum on days 3 and 4 (15th and 126th), with a chance that fluence will exceed the 1e8 integrated electron fluence levels on day 3 (15th) or more likely day 4 (16th).

The latest REFM is considered to provide good guidance with regards to the trend, however it is based on the electron flux observed over the past rotation and as such, will not have taken the possible CME arrival into account. The rise may therefore be delayed by at least 24 hours.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 10 | 30 | 50 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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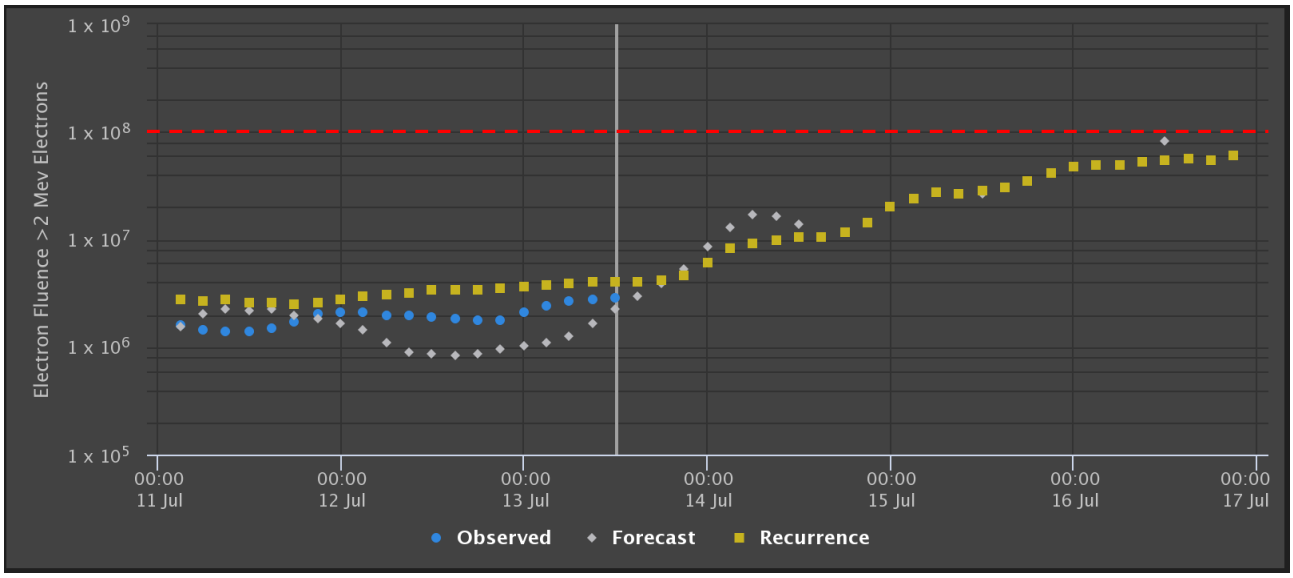
**Figure 4: MOSWOC REF Model shows fluence levels slowly rising over the next few days.**

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